What is claimed is:

1. A method for reducing noise in a digital image comprising pixels, the method comprising the steps of:

computing global statistics from the image;

for each of a plurality of image pixels:

computing local statistics for the pixel;

using the local and global statistics to configure a local filter for filtering that pixel; and

filtering the pixel using the local filter to reduce image noise.

2. The method of claim 1, wherein the step of computing the global statistics further comprises the steps of estimating the global noise standard deviation σ to generate the global statistics.

3. The method of claim 1, wherein the step of computing the local statistics for each pixel further includes the steps of:

selecting a window containing said pixel and a plurality of neighboring pixels;

computing the 2-D local variance of said pixel based on information related to the pixels in the window;

computing the 1-D local variances along multiple directions through said pixel within the window; and

detecting the local edge direction by selecting one of the direction with the smallest 1-D local variance.

4. The method of claim 1, wherein the step of computing the local statistics for each pixel further includes the steps of:

selecting a window containing said pixel and a plurality of neighboring pixels;

computing the 2-D local variance σ_0^2 of said pixel based on information related to the pixels in the window;

computing the 1-D local variances σ_1^2, σ_2^2, σ_3^2, and σ_4^2 along the horizontal (L_1), vertical (L_2), diagonal from upper left to lower right (L_3), and diagonal from upper right to lower left (L_4) directions through said pixel, respectively, within the window; and

detecting the local edge direction by selecting one of the directions with the smallest 1-D local variance.

5. The method of claim 1, wherein the step of configuring the local filter for each pixel using the local and global statistics further includes the steps of:

selecting the detected local edge direction L as the direction of the local filter;

for the detected local edge direction L computing the 1-D filter strength as a function of the square root of the local variance and the global noise standard deviation;

computing the 2-D filter strength as a function of the local variance and the global noise standard deviation; and

configuring the local filter for the detected local edge direction L based on the 1-D and 2-D filter strengths.

6. The method of claim 5, wherein the step of configuring the local filter for each pixel using the local and global statistics further includes the steps of:

selecting the detected local edge direction L_k (k = 1, 2, 3, or 4) as the direction of the local filter;

for the detected local edge direction L_k computing the 1-D filter strength $\alpha_k = \min(2\sigma, \max(3\sigma - \sigma_k, 0))/(2\sigma)$;

computing the 2-D filter strength $\alpha_0 = \min(2\sigma, \max(3\sigma - \sigma_0, 0))/(2\sigma)$; and

configuring the local filter f_k for the detected local edge direction L_k according to the following conditions:

(i) if the detected direction is L_1, then f_1 is configured as a 2-D local filter for horizontal direction, wherein:

$$f_1 = \frac{1}{9}\begin{bmatrix} \alpha_0 & \alpha_0 & \alpha_0 \\ \alpha_0 + 3\alpha_1(1-\alpha_0) & \alpha_0 + 3(3-2\alpha_1)(1-\alpha_0) & \alpha_0 + 3\alpha_1(1-\alpha_0) \\ \alpha_0 & \alpha_0 & \alpha_0 \end{bmatrix};$$

(ii) if the detected direction is L_2, then f_2 is configured as a 2-D local filter for vertical direction, wherein:

$$f_2 = \frac{1}{9}\begin{bmatrix} \alpha_0 & \alpha_0 + 3\alpha_2(1-\alpha_0) & \alpha_0 \\ \alpha_0 & \alpha_0 + 3(3-2\alpha_2)(1-\alpha_0) & \alpha_0 \\ \alpha_0 & \alpha_0 + 3\alpha_2(1-\alpha_0) & \alpha_0 \end{bmatrix};$$

(iii) if the detected direction is L_3, then f_3 is configured as a 2-D local filter for the diagonal direction from upper left to lower right, wherein:

$$f_3 = \frac{1}{9}\begin{bmatrix} \alpha_0 + 3\alpha_3(1-\alpha_0) & \alpha_0 & \alpha_0 \\ \alpha_0 & \alpha_0 + 3(3-2\alpha_3)(1-\alpha_0) & \alpha_0 \\ \alpha_0 & \alpha_0 & \alpha_0 + 3\alpha_3(1-\alpha_0) \end{bmatrix};$$

and

(iv) if the detected direction is L_4, then f_4 is configured as a 2-D local filter for the diagonal direction from upper right to lower left, wherein:

$$f_4 = \frac{1}{9}\begin{bmatrix} \alpha_0 & \alpha_0 & \alpha_0 + 3\alpha_4(1-\alpha_0) \\ \alpha_0 & \alpha_0 + 3(3-2\alpha_4)(1-\alpha_0) & \alpha_0 \\ \alpha_0 + 3\alpha_4(1-\alpha_0) & \alpha_0 & \alpha_0 \end{bmatrix}.$$

7. The method of claim 2, wherein the steps of estimating the global noise standard deviation σ further includes the steps of:

dividing the input image into overlapping or non-overlapping blocks;

computing the mean and the standard deviation for each block;

finding the smallest standard deviation d_0 and its corresponding mean m_0;

detecting block saturation due to noise;

compensating for the smallest standard deviation d_0 to generate a compensated smallest standard deviation $\tilde{d}_0$;

selecting the block standard deviations d_n that are within a range of the compensated smallest standard deviation $\tilde{d}_0$; and

averaging the selected block standard deviations d_n to generate an estimate of the global noise standard deviation σ.

8. The method of claim 7, wherein the block size is 7×7 or 5×9 pixels.

9. The method of claim 7, wherein the steps of detecting saturation and compensating the smallest standard deviation further include the steps of determining the following:

defining is an upper pixel value limit *UL*, a lower pixel value limit *LL*, and mid value *M* between *UL* and *LL*,

wherein if the mean m_0 is less than the mid range *M*, and the smallest standard deviation is greater than the difference between the mean m_0 and the lower limit *LL*, then saturation has occurred at the lower limit *LL*, and the smallest standard deviation d_0 is compensated by adding thereto a compensation term that is a function of the smallest standard deviation d_0 and said difference between the mean m_0 and the lower limit *LL*, to generate the compensated smallest standard deviation $\tilde{d}_0$;

else if the mid range M is less than the mean m_0, and the smallest standard deviation d_0 is greater than the difference between the upper limit UL and the mean m_0, then saturation has occurred at the upper limit UL, and the smallest standard deviation d_0 is compensated by adding thereto a compensation term that is a function of the smallest standard deviation d_0 and said difference between the upper limit UL and the mean m_0, to generate the compensated smallest standard deviation $\tilde{d}_0$;

otherwise, no saturation has occurred, wherein $\tilde{d}_0 = d_0$.

10. The method of claim 7, wherein the steps of detecting saturation and compensating the smallest standard deviation further include the steps of determining the following:

where UL is an upper pixel value limit, LL is a lower pixel value limit, and $UL < M < LL$, if the mean $m_0 < M$ and the smallest standard deviation $d_0 > m_0 - LL$, then saturation has occurred at the lower limit LL, wherein d_0 is compensated as $\tilde{d}_0 = d_0 + K \cdot (d_0 - (m_0 - LL))$, such that K is a compensation factor;

else if the mean $m_0 \geq M$ and the smallest standard deviation $d_0 > UL - m_0$, then saturation has occurred at the upper limit *UL*, wherein d_0 is compensated as $\tilde{d}_0 = d_0 + K \cdot (d_0 - (UL - m_0))$;

otherwise, no saturation has occurred, wherein $\tilde{d}_0 = d_0$.

11. The method of claim 10, wherein *LL* = 0, *UL* = 255, and *M* = 128.

12. The method of claim 7, wherein the step of selecting the block standard deviations further includes the steps of selecting the block standard deviation d_n for averaging if $|d_n - \tilde{d}_0| < \max(\tilde{d}_0, 1)$.

13. A noise reduction system for reducing noise in a digital image comprising pixels, the system comprising:

a global statistics module that computes global statistics from the image;

a local statistics module that computes local statistics for each of a plurality of image pixels;

a filter configuration module that uses the local and global statistics for a pixel to configure a local filter for filtering that pixel; and

a filter that as configured filters the pixel to reduce image noise.

14. The system of claim 13, wherein the global statistics module estimates the global noise standard deviation σ to generate the global statistics.

15. The system of claim 13, wherein the local statistics module computes the local statistics for each pixel by:

selecting a window containing said pixel and a plurality of neighboring pixels;

computing the 2-D local variance of said pixel based on information related to the pixels in the window;

computing the 1-D local variances along multiple directions through said pixel within the window; and

detecting the local edge direction by selecting one of the direction with the smallest 1-D local variance.

16. The system of claim 13, wherein the local statistics module computes the local statistics for each pixel by:

selecting a window containing said pixel and a plurality of neighboring pixels;

computing the 2-D local variance σ_0^2 of said pixel based on information related to the pixels in the window;

computing the 1-D local variances σ_1^2, σ_2^2, σ_3^2, and σ_4^2 along the horizontal (L_1), vertical (L_2), diagonal from upper left to lower right (L_3), and diagonal from upper right to lower left (L_4) directions through said pixel, respectively, within the window; and

detecting the local edge direction by selecting one of the directions with the smallest 1-D local variance.

17. The system of claim 13, wherein the filter configuration module configures the local filter for each pixel using the local and global statistics by:

selecting the detected local edge direction L as the direction of the local filter;

for the detected local edge direction L computing the 1-D filter strength as a function of the square root of the local variance and the global noise standard deviation;

computing the 2-D filter strength as a function of the local variance and the global noise standard deviation; and

configuring the local filter for the detected local edge direction L based on the 1-D and 2-D filter strengths.

18. The system of claim 17, wherein the filter configuration module configured the local filter for each pixel using the local and global statistics by:

selecting the detected local edge direction L_k (k = 1, 2, 3, or 4) as the direction of the local filter;

for the detected local edge direction L_k computing the 1-D filter strength $\alpha_k = \min(2\sigma, \max(3\sigma - \sigma_k, 0))/(2\sigma)$;

computing the 2-D filter strength $\alpha_0 = \min(2\sigma, \max(3\sigma - \sigma_0, 0))/(2\sigma)$; and

configuring the local filter f_k for the detected local edge direction L_k according to the following conditions:

(i) if the detected direction is L_1, then f_1 is configured as a 2-D local filter for horizontal direction, wherein:

$$f_1 = \frac{1}{9}\begin{bmatrix} \alpha_0 & \alpha_0 & \alpha_0 \\ \alpha_0 + 3\alpha_1(1-\alpha_0) & \alpha_0 + 3(3-2\alpha_1)(1-\alpha_0) & \alpha_0 + 3\alpha_1(1-\alpha_0) \\ \alpha_0 & \alpha_0 & \alpha_0 \end{bmatrix};$$

(ii) if the detected direction is L_2, then f_2 is configured as a 2-D local filter for vertical direction, wherein:

$$f_2 = \frac{1}{9}\begin{bmatrix} \alpha_0 & \alpha_0 + 3\alpha_2(1-\alpha_0) & \alpha_0 \\ \alpha_0 & \alpha_0 + 3(3-2\alpha_2)(1-\alpha_0) & \alpha_0 \\ \alpha_0 & \alpha_0 + 3\alpha_2(1-\alpha_0) & \alpha_0 \end{bmatrix};$$

(iii) if the detected direction is L_3, then f_3 is configured as a 2-D local filter for the diagonal direction from upper left to lower right, wherein:

$$f_3 = \frac{1}{9}\begin{bmatrix} \alpha_0 + 3\alpha_3(1-\alpha_0) & \alpha_0 & \alpha_0 \\ \alpha_0 & \alpha_0 + 3(3-2\alpha_3)(1-\alpha_0) & \alpha_0 \\ \alpha_0 & \alpha_0 & \alpha_0 + 3\alpha_3(1-\alpha_0) \end{bmatrix};$$

and

(iv) if the detected direction is L_4, then f_4 is configured as a 2-D local filter for the diagonal direction from upper right to lower left, wherein:

$$f_4 = \frac{1}{9}\begin{bmatrix} \alpha_0 & \alpha_0 & \alpha_0 + 3\alpha_4(1-\alpha_0) \\ \alpha_0 & \alpha_0 + 3(3-2\alpha_4)(1-\alpha_0) & \alpha_0 \\ \alpha_0 + 3\alpha_4(1-\alpha_0) & \alpha_0 & \alpha_0 \end{bmatrix}.$$

19. The system of claim 14, wherein the input image comprises overlapping or non-overlapping blocks, and wherein the global statistics module further comprises:

a mean and standard deviation module that computes the mean and the standard deviation for each block ;

a minimum finder module that finds the smallest standard deviation d_0 and its corresponding mean m_0;

a saturation detector that detects block saturation due to noise;

a saturation compensator that compensates for the smallest standard deviation d_0 to generate a compensated smallest standard deviation $\tilde{d}_0$; and

a selective averaging module that selects the block standard deviations d_n that are within a range of the compensated smallest standard deviation $\tilde{d}_0$, and averages the selected block standard deviations d_n to generate an estimate of the global noise standard deviation σ.

20. The system of claim 19, wherein the block size is 7×7 or 5×9 pixels.

21. The system of claim 19, wherein:

an upper pixel value limit is denoted *UL*, a lower pixel value limit is denoted *LL*, and a mid value *M* is between *UL* and *LL*,

wherein the saturation detector determines if the mean m_0 is less than the mid range *M*, and the smallest standard deviation is greater than the difference between the mean m_0 and the lower limit *LL*, indicating that saturation has occurred at the lower limit *LL*, and if so, the saturation compensator compensates the smallest standard deviation d_0 is by adding thereto a compensation term that is a function of the smallest standard deviation d_0 and said difference between the mean m_0 and the lower limit *LL*, to generate the compensated smallest standard deviation $\tilde{d}_0$;

else if the saturation detector determines that the mid range *M* is less than the mean m_0, and the smallest standard deviation d_0 is greater than the difference between the upper limit *UL* and the mean m_0, indicating saturation has occurred at the upper limit *UL*, the saturation compensator compensates the smallest standard deviation d_0 by adding thereto a compensation term that is a function of the smallest standard deviation d_0 and said difference

between the upper limit *UL* and the mean m_0, to generate the compensated smallest standard deviation $\tilde{d}_0$;

otherwise, no saturation has occurred, wherein $\tilde{d}_0 = d_0$.

22. The system of claim 21, wherein:

if the mean $m_0 < M$ and the smallest standard deviation $d_0 > m_0 - LL$, indicating saturation has occurred at the lower limit *LL*, then d_0 is compensated as $\tilde{d}_0 = d_0 + K \cdot (d_0 - (m_0 - LL))$, such that K is a compensation factor;

else if the mean $m_0 \geq M$ and the smallest standard deviation $d_0 > UL - m_0$, indicating saturation has occurred at the upper limit *UL*, then d_0 is compensated as $\tilde{d}_0 = d_0 + K \cdot (d_0 - (UL - m_0))$;

otherwise, no saturation has occurred, wherein $\tilde{d}_0 = d_0$.

23. The system of claim 22, wherein *LL* = 0, *UL* = 255, and *M* = 128.

24. The system of claim 19, wherein block standard deviations d_n are selected for averaging if $|d_n - \tilde{d}_0| < \max(\tilde{d}_0, 1)$.